Redefining MRI:
From Image to Insight

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Recent Deep Learning Enhanced MR Techniques and Images

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Long scan time is one of the fundamental limitation of volumetric MR imaging. With conventional parallel imaging, noise amplification and aliasing artifacts are introduced at high acceleration factors owing to coil geometry and g-factor constraints, and with compressed sensing, blocky and unnatural textures are frequently produced by handcrafted sparsity-enforcing regularization, particularly for highly undersampled, low-SNR data.

To overcome these limitations, a physics-based deep learning reconstruction technique founded on unrolled optimization, has been developed. The physics-based deep learning model, in which Fourier encoding and coil sensitivity information are explicitly incorporated, is embedded in the network, and the iterative optimization of model-based reconstruction is unrolled into a sequence of network iterations. Each iteration is composed of a data consistency unit, by which fidelity to the acquired multi-coil k-space samples is enforced, and a regularization unit, in which data-driven priors are applied by convolutional neural networks with dense skip-layer connections. Complex-valued images are thereby reconstructed directly from highly undersampled k-space data.

Up to 12-fold acceleration and up to 86% scan time reduction can be achieved, and compatibility is provided with 3D fast spin echo (Cube) and 3D gradient echo-based sequences for neuro, spine, body, and musculoskeletal imaging. Compared with Autocalibrating Reconstruction for Cartesian imaging (ARC), fewer artifacts and higher SNR were demonstrated even at high acceleration factors, and diagnostic image quality was preserved at a speed factor of 12.

It is concluded that highly accelerated volumetric MRI is enabled by the physics-based unrolled reconstruction while diagnostic image quality is preserved.

Keywords: *Deep learning, Parallel imaging, Physics based model*